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US ARMY MEDICAL RESEARCH LABORATORY

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REPORT NO. 918

CARGO CODING DEVELOPMENTS IN MILITARY BLOOD BANK LOGISTICS

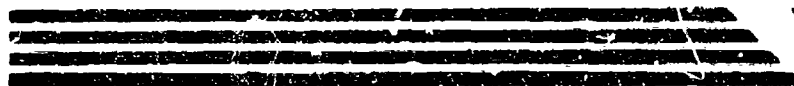
(Progress Report)

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4 February 1971

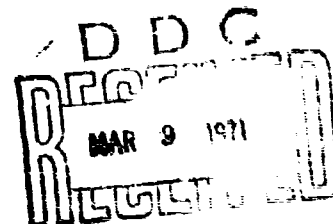
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4 February 1971

Evaluation of Blood Banking Preservation and Logistics
Work Unit No. 155
Combat Surgery
Task No. 00
Combat Surgery
Project No. 3A062110A821

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ABSTRACT

CARGO CODING DEVELOPMENTS IN MILITARY BLOOD BANK LOGISTICS

OBJECTIVE

To demonstrate the potentiality and criticality for establishing and assigning a specific cargo code to blood and blood products destined for shipment within the United States and overseas.

RESULTS

Substantial evidence supports the hypothesis that the quality of blood or blood products which a recipient receives is in a large measure dependent upon the time loss factor encountered at shipping terminals. Proper execution of assigned coding would establish critical priorities and thereby alleviate detrimental delays.

CONCLUSIONS

The findings in this study clearly point out that the same degree of efficacy prevailing in a good blood processing laboratory must also prevail in the minds of those who process the blood shipments at various shipping terminals. Specific problems are cited which can only be resolved by a coding system designed for shipment of blood, blood components, and human tissues for transplant procedures. A highly successful technique for packaging frozen components (fresh frozen plasma and cryoprecipitate), which are extremely fragile, is illustrated in a supplement to this report.

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CARGO CODING DEVELOPMENTS IN MILITARY BLOOD BANK LOGISTICS*

INTRODUCTION

New methods and technics for procuring, preserving, and administering whole blood and components are continually being implemented in the military blood bank. Basic research and clinical experience dictate a constant reevaluation, updating, and incorporation of new procedures. The complexity and interdependency of the many facets that make up a well-functioning modern blood bank demand uniform progress in all segments of the program. For example, Shields et al reported that the shelf life of whole blood may be increased twofold (4). In order to realize maximum benefit from this particular achievement, the design of blood shipping containers used for long-distance shipping becomes a critical part of the blood program. Better protection against marked fluctuations in temperature in the blood during shipment is essential, and for longer periods, if the quality of blood is to be maintained.

The importance of the need for a better shipping container was reported in Transfusion by Bellamy, under the title "Design and Test Consideration to Provide and Improve Blood Shipping Containers" (1). In addition, two technical reports, 809 and 842, appeared from the US Army Medical Research Laboratory, Fort Knox, Kentucky, by McPeak et al, entitled "Effects of Environmental Temperature on Selected Blood Shipping Containers," (3) and "Blood Shipping Boxes Evaluated Under Various Modes of Heat Transfer" (2). These reports clearly depict the interrelationship and interdependency of the operation within a blood banking system.

* Presented at the Annual Meeting of the American Association of Blood Banks, San Francisco, California, Nov 1970.

¹ Bellamy, D. Design and test considerations to provide an improved blood shipping container. Transfusion, 5: 550, 1965.

² McPeak, D. W. and C. E. Shields. Blood shipping boxes evaluated under varying modes of heat exposure. USAMRL Report No. 842, 5 Dec 1969 (DDC AD No. 703179).

³ McPeak, D. W., C. E. Shields, and F. R. Camp, Jr. Effects of environmental temperature on selected blood shipping containers. USAMRL Report No. 809, 2 Apr 1969 (DDC AD No. 692281).

⁴ Shields, C. E. and F. R. Camp, Jr. Comparison studies of whole blood stored in ACD and CPD and with adenine. USAMRL Report No. 719, 21 Mar 1967 (DDC AD No. 654504).

The purpose of this report is to call attention to that phase of blood banking far removed from the processing laboratory, yet very vital to the overall blood program; that is, shipping. The quality of blood the patient receives is in a large measure dependent upon the care rendered the blood by different handlers and carriers along the shipping routes, irrespective of the expertise and competence of the laboratory personnel who prepare the blood.

METHODS

During the past three years, the Blood Transfusion Division of this research laboratory, has shipped large quantities of blood and components to different parts of the world. Figure 1 shows the standard blood box prepared for shipment. The importance of cargo coding has been borne out as a result of this experience. Recently, with the cooperation of personnel at Walter Reed Army Blood Bank, Washington, D. C., a study was made of components shipped by commercial carrier, with and without a courier. The results indicated that the minimum time required with courier from the blood bank at Fort Knox to the blood bank at Walter Reed was 3-1/2 hours. Actual flying time, however, is only 1 hour and 20 minutes.

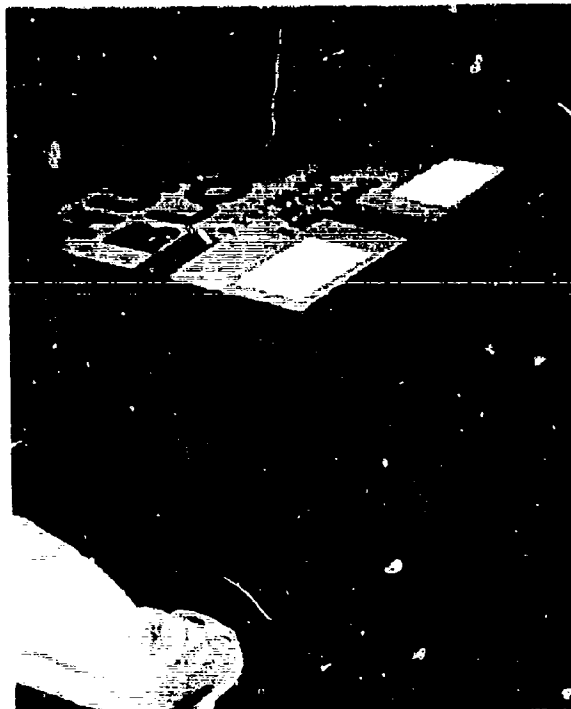


Fig. 1. Standard blood box prepared for shipment.

Without a courier, the delivery time was often doubled because of inattention to coding. The conditions for closely coordinated pickups were much more ideal in this instance than could be expected on longer shipments, when more than one airline might be involved with the increasing opportunity for delays. The results of the study are representative of the larger overall shipping phase of blood banking.

The Blood Transfusion Division, US Army Medical Research Laboratory, has been engaged in studies to improve blood preservation and transport of blood and blood components. The interrelationships are apparent. The applications resulting from blood preservation and transport research studies have led to the use of the term "Blood Bank Inventory Logistics System." To properly evaluate and investigate new methods, the logistical problem was separated into three categories: shipping container, carrier control, and in-transit and on-hand inventories.

RESULTS

From observations and experience, it has been shown that blood and related biologic products should be handled as separately identified cargo to insure immediate acceptance for transportation, proper protection en route, and prompt, punctual delivery. The concept of cargo coding for blood, blood components, biologicals, and body organs has been proposed to the Department of Defense Military Blood Program Agency (DODMBPA). It is now considered essential to continually monitor the cargo coding of human blood and all living tissues. Some of the planning factors have been suggested by the DODMBPA. These include large air freight operations contemplated in the future and special handling, including arrangements in the air freight terminals for adequate refrigerators with recording systems and alarms for temperature control. The cost of such special handling must be a significant element of the current study.

Accounting for units of whole blood in process, en route, on order, and on hand is, in essence, today's blood bank operation. This includes collection, storage, shipment (movement, distribution), receiving, and utilization. It affects cost, conservation, personnel, quality control, and most important, routine and emergency situations, expanded use of blood components, expanding services supporting open heart surgery and organ transplants, and in particular, patient care.

DISCUSSION

There exists a need for the proper control of whole blood and related biological products during shipment. Interstate Commerce Commission regulations have established controls of items such as narcotics, inflammables, acids, precious metals, radioactive materials, etc., while in transit. These controls are commonly called "Cargo Codes" and relate to all shipments by any type of carrier and govern all shippers within industry and the military.

Department of Defense Directive 4500.32-R, Appendix B3, prescribes present military procedures with regard to coding and special handling of air shipments of whole blood entering the Defense Transportation System. It would appear to be too limited in scope for complete effectiveness.

In the military, transfer of a shipment from one carrier to another, i.e., surface transportation to aircraft to aircraft to surface transportation is a common practice. Nonacceptance of whole blood shipments due to flight cancellation is a factor to be considered. Advance space reservation for air transportation is sometimes required and, since an emergency shipment of whole blood is considered a routine procedure for blood banks, this advance reservation requirement presents a significant obstacle.

The cargo code should consider all of these special requirements. DODMBPA has initiated a request for consideration to resolve this problem. It is felt that guidance for consignors and carriers is essential.

The length of the supply chain, coupled with donor sources, loading and off-loading points, consolidation and short-life usability suggest the concept of Blood Bank Logistical Inventory System. Innovations in transportation, packaging, and data dissemination have suggested new administrative concepts for accomplishment of this mission. To properly evaluate and investigate new methods, the logistical problem was separated into three categories: shipping container, carrier control, and in-transit and on-hand inventories.

The major problems encountered by blood banks shipping blood, and hospitals receiving blood, seem to be common to all installations. Very often blood is not received on schedule and is lost or, if found, is no longer usable. Initial shipments without a courier or a telephone walk-through to new stations are laden with difficulties. Some factors which cause a seemingly well-functioning transport system to falter are elements influenced by weather such as snow, rain, and fog. These elements slow down loading and unloading operations at the terminals, and cause an already heavy air traffic situation to become heavier, resulting in further delay. Personnel at air terminals, bus, truck, and limousine stations who are unfamiliar with the intrinsic value or nature of the cargo pose additional problems. Re-icing of blood boxes requiring wet or dry ice tends to confuse employees at the terminals, along with technical terminology such as centigrade, fahrenheit, blood fractions, and blood components. Unfamiliar terminology, coupled with overworked conditions and a myriad of other problems common to small and large operations alike, provide the impetus for the development of a more specific coding system.

SUPPLEMENT

Early work by Gibson et al has shown that the red blood cell is very durable and can withstand a considerable amount of buffeting providing it is adequately refrigerated (1). Subsequent to Gibson's work, the plastic bag has been accepted as the universal blood container replacing the glass bottle. Although this plastic bag has many advantages over the glass bottle formerly used, it is most vulnerable to physical stress (3). Extensive damage occurs when the container is used for shipping fresh frozen plasma. Figure 1 is a typical example. This unit is part of a larger shipment of fresh frozen plasma received at the US Army Medical Research Laboratory from Germany (Fig. 2).

The tendency of the plastic bag rupturing when under physical stress plus becoming brittle when frozen indicated a need for added protection if it is to withstand shipment under the present coding system. An interim container is shown in Figure 3. Although the erythrocyte does not show a gross mechanical breakdown when subjected to reasonable abuse both the cell and the container ultimately would benefit from better cushioning. Data presented in a recent report on materials and methods for air delivery of whole blood and blood products describe the superb qualities of an air bubble packaging material (Air Cap[®]) (2).

Figures 4-11 pictorially present a procedure (step-by-step) for packing fresh frozen plasma in Air Cap.[®] This method, when judiciously followed, has repeatedly increased substantially the number of salvageable units of fresh frozen plasma following shipment.

* Cryoprecipitate can be packaged in a similar manner.

¹ Gibson, J. G., T. Sack, R. D. Evans, and W. C. Peacock. The effect of varying temperatures on the posttransfusion survival of whole blood during depot storage and after transportation by land and air. J. Clin. Invest. 26: 747, 1947.

² Shields, C. E., D. W. McPeak, J. C. Rothwell, G. H. Seeger, and F. R. Camp, Jr. Investigation of materials and methods for air delivery of whole blood and blood products. Milit. Med. 133: 614, 1968; USAMRL Report No. 762, 24 Jan 1968 (DDC AD No. 666177).

³ Technical Report: Overpack for Medical supplies. Thiokol Chemical Corporation, Bristol, Pennsylvania, Dec 1964.

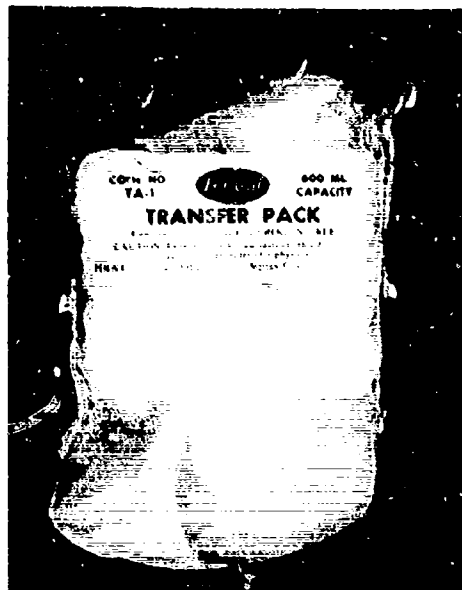


Fig. 1. Plastic bag of fresh frozen plasma damaged in shipment.



Fig. 2. Damaged shipment of fresh frozen plasma received at the US Army Medical Research Laboratory from Germany.



Fig. 3. An interim container for fresh frozen plasma.



Fig. 4. Place unit of frozen plasma in plastic bag.



Fig. 5. Fill Air Cap envelope with 3 cups of dry ice.



Fig. 6. Place frozen plasma unit in Air Cap envelope with dry ice.

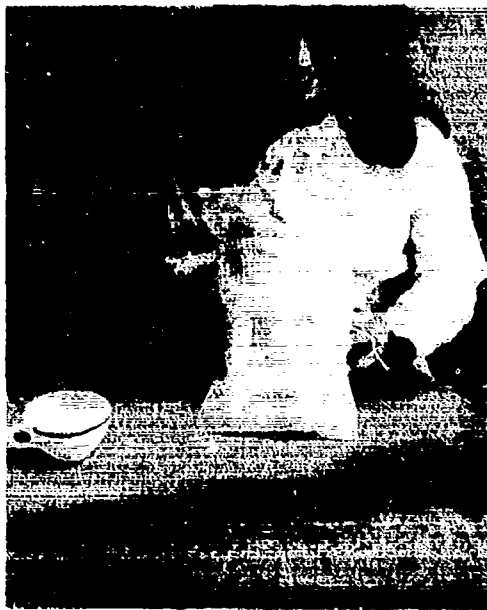


Fig. 7. Fold top of Air Cap envelope.

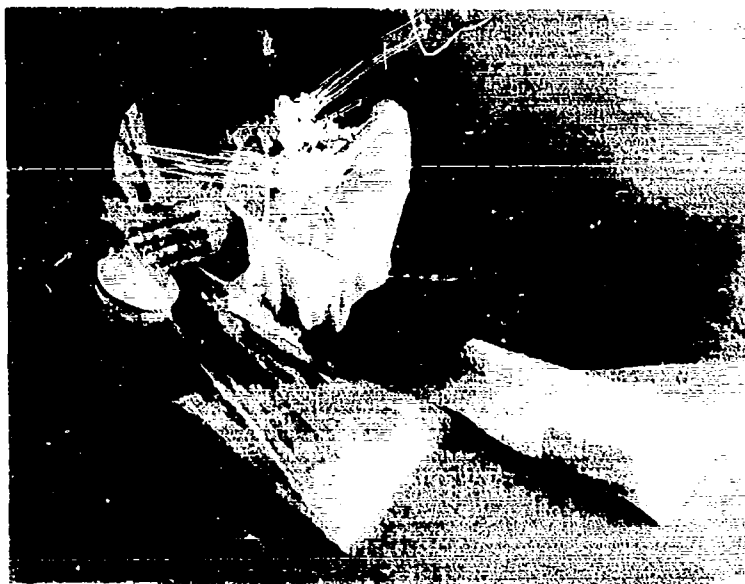


Fig. 8. Fill larger plastic bag with 3 cups of dry ice.



Fig. 9. Place Air Cap bag containing dry ice and frozen plasma in the larger plastic bag.



Fig. 10. Additional dry ice may be added to Air Cap envelope if a long shipment is contemplated.



Fig. 11. Secure open end of the larger plastic bag.

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